SPAFFORD - WHEEL-CARRIAGES - ALBANY, 1815

SOME

CURSORY OBSERVATIONS

ON THE

ORDINARY CONSTRUCTION

OF

WHEEL-CARRIAGES:

WITH

AN ATTEMPT TO POINT OUT THEIR DEFECTS,

AND TO SHOW

HOW THEY MAY BE IMPROVED;

WHEREBY A SAVING MAY BE MADE IN THE POWER APPLIED, THE MOTION BE RENDERED MORE UNIFORM AND EASY,

AND

THE DANGER OF UPSETTING MOST EFFECTUALLY PREVENTED.

With appropriate Engravings.

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PREFATORY OBSERVATIONS.

UNTIL I reflected that Parental solicitude is not lessened by the diminutive size of the child, I could not understand the solicitude and hesitancy which I felt about presenting this little thing to the public. It is indeed a very small book; but as it contains about all that I wished now to say on this subject, I have concluded to make it the medium of calling the public attention to an examination of its merits and importance. Should it have that effect, and should it attach to its investigations, the interest and importance which the subject well merits, small as the book is, it will have performed all that I expected of it. And with fervent wishes that every Parent;—and that every Author, whether of a large book or a small one, may ever enjoy that full satisfaction, I present my little pamphlet to the public.

H. G. S.

ALBANY, 1 Mo. 11, 1815.
19 *Hamilton-street.*

OBSERVATIONS, &c.

REASON, science and philosophy, having long since taught every body that high wheels for carriages move much easier than low ones, the fact, as it will not be questioned, needs no examination here. That it is so is beyond a doubt. Various attempts have been made to avail ourselves of the advantage of considerably higher wheels; and we accordingly see that, wherever it can be done without a counterbalancing inconvenience, wheels of a greater height are substituted for the lower ones of former times. If still higher ones than we now see have not been used, it is solely because no plan has been devised to remedy the inconvenience of too high a line of draught for the horse, and the increased height of the load or body of the carriage. For it is also as generally believed that the line of draught should be, what may be termed a lifting-line; that is, that the horse's breast should be rather higher than the level of the line of draught. This is undoubtedly correct, and I believe there ought, for his ease, and to enable him to exert his full power, to be a greater difference than there commonly is in practice: this however, would require the wheels to be still smaller. To all these difficulties and objections to the use of high wheels, we may add another, and that of commanding influence in the construction of pleasure, and other carriages designed for rapid motion. That as we extend the height of the wheels, we increase the exposure to upsetting, and the danger attending it: For as the higher the wheel, the longer is the lever on which its motion acts; and as the axle, on which the load rests is necessarily in the centre of the wheel, it is evident that the higher the wheel the greater is the liability to upset.

Such, I believe, are the reasons why the wheels of carriages ought, for the ease of the horse and for the ease of the rider, to be made much higher than those in common use; and such the objections to any increase of height. Perhaps it may be admitted with propriety, that the height of wheels now employed, is about that medium which best combines every practicable advantage, with the fewest disadvantages. But, when I say this, I mean to

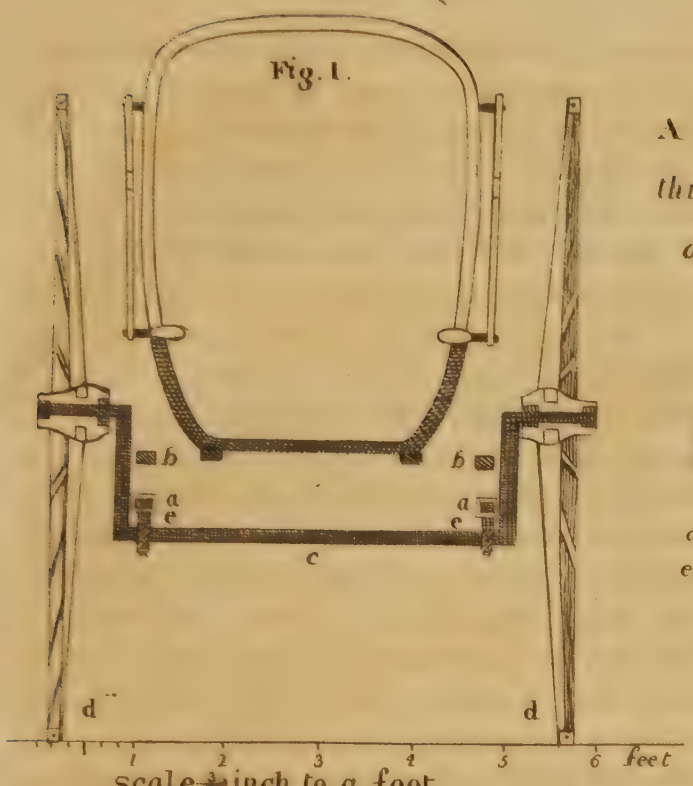
be understood as saying it of the present mode of constructing wheel-carriages with straight axles, which necessarily raise the load above the centre of the wheels. For while I anticipate the fullest conviction of truth and reason in all the above premises, I expect, as a natural consequence, that, pointing out a complete extension of every desired advantage, with a remedy for every disadvantage, the improvement will be eagerly adopted :—or at least, that reason, science and philosophy, will accord to it the meed of their approbation.

Suppose it practicable to increase the height of the wheels of a Chaise, for instance, to any desirable extent, and that not only without any inconvenience to the draught, or the height of the load, but with an actual advantage from the manner of appending it. This would readily be pronounced the grand desideratum, while, as it never has been done, it would, perhaps, as readily be pronounced impossible. And suppose it should be added that all this could be effected, and in such a way, as most effectually to guard against the danger of upsetting ? But—although I am confident of having effected all this, and more, let me be cautious how I promise too much for belief, for it is a great deal, and proceed to show what I have done and how I have effected it.

It will have been perceived that I propose a considerable addition to the height of carriage-wheels ;—and to remedy the inconvenience arising from this, I use a crooked, or what the coach-makers propose to call a cranked axle, such as is shown in figure 1, resting the load on the crank, below the direct or right line of the axes of the wheels. The figure will be perfectly understood, and words may be spared. The height of the wheels is 7 feet, and the crank of the axle 15 inches. The shafts, attached to the axle at a a,* are connected with it by the joints e e, which allow the axle to move freely back and forth when the carriage is in motion, and to adjust itself to the various positions required by the laws of gravity. But this is more particularly explained in figure 2; and I will only observe here that while the carriage is in motion, on roads of the common unevenness of surface, this crank will be constantly changing its actual position, as respects the axes of the wheels: because its relative position to these axes,

* See also fig. 2, where the parts are designated by the same letters. The wheels have 16 spokes.

Fig. 1.

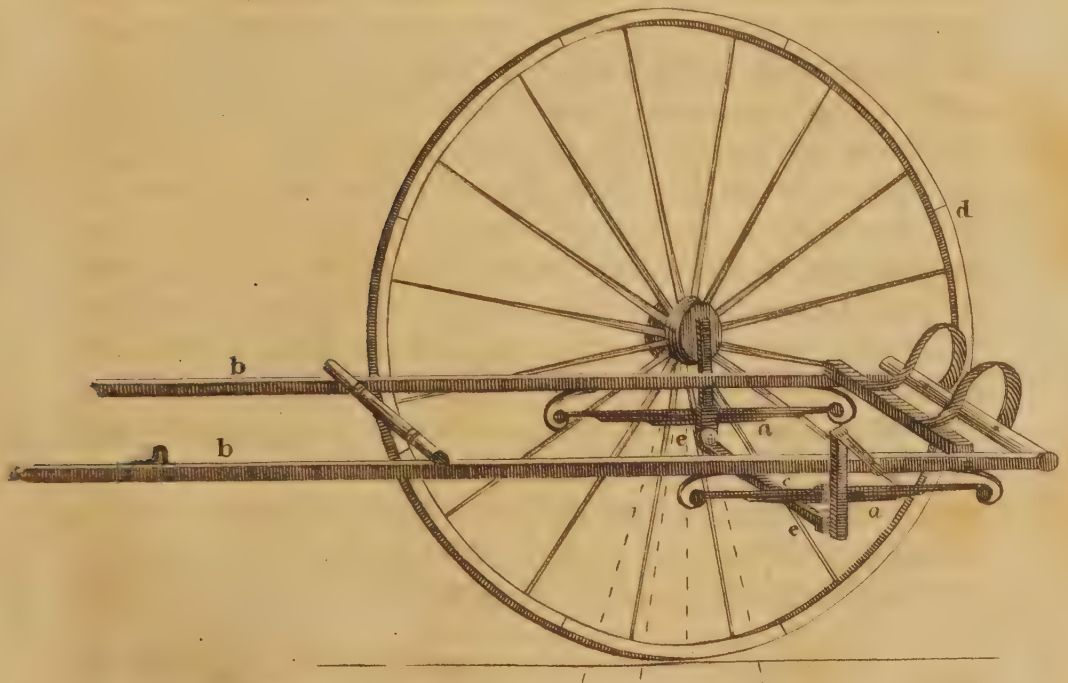


scale 1 inch to a foot.

A Vertical Section;
through the centre
of the axle, wheels,
and body.

a a cradle springs.
b b shafts.
c axle.
d d wheels.
e e joints.

Fig. 2.



Perspective View. the left wheel being taken off.

is all the while adapting itself to a kind of compound line of gravity, by which it will hang nearly in the direction of that line. This line of gravity is always intermediate, between the horizontal line of progression, and the natural perpendicular of gravity; and results from the well known laws of gravity applied to moving bodies. In the case of carriage-wheels, it may be called a compound line of gravity, resulting from the nature of their peculiar motion. It never falls perpendicularly under the axes, only when the wheels are at rest; and then the crank in the above axle, which sustains the load, hangs perpendicularly under them. If the load be light, and the motion slow, over an even surface, this variable line of gravity will fall but little forward of the perpendicular; but always some, as shall be explained. If, on the contrary, the load be heavy, the motion rapid, and the road uneven or rough, the line of gravity will fall very considerably forward of the perpendicular, and the crank will hang forward in that direction. On ascending a hill, where the resistance is great, even though the motion be slow, the crank hangs forward in the same proportion; that is, always according to the resistance to the motion of the carriage, and the power applied to overcome that resistance.

Descending the hill, where the load presses the carriage upon the horse, if he hold back, the action is reversed and the crank hangs behind the perpendicular, true to this compound line of gravity, which now falls there: Because, to the weight of the load, is now added the resistance of the horse's strength, actually pushing backward, and the weight of the whole is increased by this addition That the crank can never hang exactly in the perpendicular line, when the carriage is moved by a power attached to it, will be manifest on considering that the impulse must act here, before it can do so to move the carriage.

This reasoning I believe to be undoubtedly correct, and the inferences as plain as they are important. These will be more particularly explained when considering figure 2.

This figure, like the other, requires no explanation. It is a perspective view of the same carriage, having the same proportions, but with the left wheel taken off, to render the view more distinct and plain. The crank of the axle is here shown in its whole length, and the several parts in their natural adjustment and proportions. The dotted lines show the variations of the line

of gravity, agreeable to what is said, page 5; and this falls sometimes before, and sometimes behind the perpendicular as is there explained.

The details of experiments, by which the ratio of the inclination of this variable or moveable line of gravity has been ascertained, would be tedious and uninteresting to the public, and are therefore omitted here. In a philosophical discussion, they would be indispensable. But—I am now writing a little pamphlet with an intention to explain the principles of my invention, for which I have obtained a Patent, and to recommend it to the attention of the public. I am satisfied of its utility and importance; and while I would cheerfully aid in the introduction of every improvement, I invite the attention of a candid, liberal, and enlightened public to examine and decide on the merits of this. If it be far less of an improvement than I suppose, or if it be pronounced none-at-all, I shall at least have offered the best essay in my power toward an improvement, and have invited the public attention to a very important branch of domestic economy.

If, however, my reasoning should be found incorrect, this subject is far less important than I had supposed: because there is not that susceptibility of improvement. Happily for me, no subject on which a doubt has existed, can be more susceptible of clear demonstration: and neither learned nor unlearned need remain in doubt whether it be correct or not, beyond the short period of a few hours.

From all the preceding observations it appears that if there be, in the nature or philosophy of the compound motion of wheel-carriages a moveable and constantly varying line of gravity, distinct from the perpendicular, natural line of gravity when at rest, it must follow that this principle may be so applied as to aid the operation of the propelling power. And, unless I wholly misconceive the principle of gravity, and its application in motion and mechanic powers, this is actually effected in the construction of the carriage which I have just described. Nor am I ignorant of the effect which this idea will produce in most minds, at the first thought. But—time, that tests and corrects all opinions and things, will speak for itself, in the order of time. I beg it may be distinctly understood that I am not supposing any great aid from the above principle; and it will be sufficient for my present purpose if it produce any aid, however small

That it will do so, in some degree, I will now endeavor to show; though I am aware that it can be better demonstrated by the actual use of a carriage constructed on the above principles.

Suppose a load, with some obstacle to the motion of the wheels, and a power applied sufficient to draw the crank of the axle forward, say 1 foot: Now as this has advanced the point on which the load is suspended 1 foot beyond the perpendicular line of gravity, the actual line of gravity must be advanced in proportion, and the wheel will overcome the obstacle with proportionate ease. So, on descending an inclined plane, or hill, where the weight of the carriage forces it upon the horse; as the line of gravity is thus carried back of the perpendicular, and falls nearer the point of contact, the pressure upon the horse is lessened by this application of the principle of a variable line of gravity. I had often observed with astonishment, before I understood this principle, that occasionally when a carriage was in rapid motion on an easy road, one of its wheels would seem to lose all its rotary momentum on striking a very small stone, and such as at other times would scarcely be perceived. The fact has often occurred to my observation, principally when passing rapidly along an easy smooth road; and I now perceive that the powerful, deadening influence, so instantaneously exerted, arose from the circumstance that the little stone presented an obstacle to the motion of the wheel, exactly in the line of its gravity. And when this happens, though the obstacle be very small, the whole rotary motion is lost, till the impulse form a new line of gravity adapted to the occasion. This inconvenience or loss of actual momentum, small as it may seem, is constantly operating in some degree to impede the motion of wheel-carriages, and effects a far greater loss of momentum than would readily be imagined. Now, from a view of my axle, it will readily appear that this loss must be comparatively very small, because of the facility with which it changes the line of gravity, on meeting with any obstacle to the motion of the wheels.

Let us examine these principles and reasonings on a larger scale, and form a chaise with wheels 20 feet in diameter, and the axle cranked 8 feet: the shafts attached as before described.

Take upon this an ordinary load, and drive at the rate of 4 miles an hour over an uneven road. The shafts are now a little more than 2 feet from the ground, and the load is at about an ordinary elevation. The ease and uniformity of the motion, are an evidence of the increased facility with which the wheels roll over obstacles. And the ever-changing position of the axle, indicating the varying line of gravity, will explain how the advantage is gained. Suppose now, with the same motion, we drive upon a stone in the road and witness how the obstacle affects the wheels, the motion of the carriage, and the position of the axle on which the shafts rest. The great length of this crank, enables the propelling power to act conspicuously upon it, and show how every proportionate extension is acted upon.

Suppose again, that to one or both of these wheels, we oppose a square log of wood, 6 inches in diameter; immediately the axle is drawn forward nearly into the direction of the line of gravity, which line is now a new one, formed to the occasion. Suppose the axle hang forward 1 foot, and it must always hang below the line of gravity; this then carries the line of gravity above, or forward of the present point of contact, and this adaptation of the axle to the direction of the variable line of gravity, facilitates the passage of the wheels over the obstacles: And it does so in exact proportion to the influence which this principle is allowed to produce on the moveable axis. Or, in other words, the more the crank of the axle be drawn out of its perpendicular, the greater is the advantage derived from it, as well in relation to the wheel, as to the uniformity of motion of the carriage, and in rendering the draught less violently unequal on the horse's breast. It will be readily understood how the motion of the crank axle will tend to equalize the motion of the carriage, and to have the effect of springs. It is well understood that whatever renders the motion of any carriage more uniform, decreases the resistance occasioned by uneven roads. I propose to use springs also, in aid of the cranked axle, and the carriage shown here rests on cradle-springs of the common form, connected with the axle by the joints, c e. Any kind of springs may be applied, to suit the interest, convenience, or fancy. The worm-spring would answer a good purpose, where elegance is not consulted

and no great degree of uniformity of motion required. But there is no method of applying the principle for which we contend in the use of springs, or at least none with which I am acquainted, that seems so perfectly consonant to the soundest principles of philosophical reasoning, as one that, having merely been, and successfully applied in speculative philosophy, is still unaccountably overlooked in practice. A bladder, nearly filled with air, and enclosed in a strong case of leather, presents an action of elasticity, acting precisely on those principles which are best calculated to meet alike the wishes and wants of the philosopher, and the mere economist in the use of springs. The elasticity and compressibility of air, are well known.—The expense of springs made in this way, would be a very trifle; and while this circumstance would recommend them to most people, let, if he will, the man of luxurious pride and vanity, find his objection in the trifling cost. No kind of spring can perform so much and so well, on very rough roads, and I hope to see them in common use. Nor ought we to forget that the gilded days of prosperity and wealth, when luxury and extravagance were comparatively cheap, are passing rapidly by us—and are even gone, never perhaps to return again.

The objection that I have sometimes heard urged against high wheels, that they would throw more mud and water than those of the common height, is founded in error. The throwing of mud is occasioned by the rapidity of rotary motion; and the fore-wheels of a coach, being smaller, have to revolve more rapidly, and of course throw more mud than the hind-wheels. The larger the wheel, the less frequent are its revolutions; and the larger it be, the less mud and water will it take up in these revolutions, and of course will throw the less. This is self-evident, as also, and as a necessary consequence of the preceding, that the larger the wheel, the less the depth that it will sink into the mud: because that, the smaller the wheel, the more sharp is the curve of its circle, presented to the ground which is to sustain it. And this difference is far greater than is generally imagined. It may readily be demonstrated, by balancing the weight equally between the fore and hind wheels of a coach, or other carriage, having wheels of a considerable difference of diameters. Nor will the fore-

wheels, when once sunk into the mud, rise out of it with the same case, as is perfectly manifest. On advancing to harder ground, its resistance would raise the hind wheels first, did they not track after the other. And while these remarks will be deemed trifling by observing men, they will be new and instructive to a great many, and will, I hope, be excused.

I have also heard a few persons object to any additional height of the wheels, on a supposition that the greater their diameter, the larger their timbers must be, and of course the heavier. This reasoning is undoubtedly correct, while we use the straight axle, and raise the load above the centre of the wheels; and as certainly incorrect, applied to the cranked axle which suspends the load below the centre of the wheel, and just so much nearer the point of contact. The longer the crank, or the lower the load hangs, the nearer it is to the point of contact of the wheel; and this point of contact is always the generating centre of its motions. The wheel is a circle of levers, one end of which must be constantly resting on the ground as the wheel rolls: and during the moment of contact, the one end is perfectly at rest, as respects any progressive motion, while the other end moves with a rapidity increased in proportion to the diameter of the wheel and the progressive motion of the carriage. The fact, therefore, is, that the strain being lessened by using the cranked axle, which brings the load nearer the point of contact, the timbers of the wheel may be proportionably smaller than those of ordinary carriages, and of course the wheels may be lighter in proportion to their diameters.

There remains yet one other circumstance in relation to wheel-carriages, which deserves far more consideration than it seems ever to have had, either in mechanism or speculative philosophy. I allude to the loss of propelling power, occasioned by a kind of wabbling, or vibratory motion of the wheels; and which in rough roads keeps them violently playing on their axes to the right and left. The increased friction in consequence of this, is very great; as by its constant action, each box is alternately acting upon its axis to increase friction, by the whole power that thus acts on the wheel, and a lever of the length of its semi-diameter. I have no doubt this subject has often excited the attention of others;

but if it had excited the attention which it merits, we should not now see so many short hubs to carriages, nor such very small axes to their wheels. The limits assigned to my little pamphlet, will not admit of discussion in this place. I can therefore only say, now, after what has been already said relative to this subject, that the compound motion of the wheels of carriages, requires for them axes of a peculiar construction, differing radically in their form and proportions, from those of wheels revolving on fixed centres.

The wabbling motion that I spoke of above, and which on rough and stony roads is constantly throwing the wheels to the right and left, is evidently much increased by the height of the load, raised above the centre of the wheels. The higher the load is raised, the greater and more violent is this motion, and the greater the friction and loss of propelling power. Stages for passengers, and pleasure-carriages, which have their loads thus raised, sustain a very great loss in this way, besides the increased inconvenience, and danger of upsetting. If, therefore, these premises be correct, there will be great advantage in these respects also, by suspending the load in the way I propose, below, rather than above the centre of the wheels.

The very great increase of travelling by Stages in the United States, within a few years past, has given an increased importance to the enquiry, whether or not the construction and form of these vehicles be susceptible of improvement? I think they may be very essentially improved; and certainly, without resorting to any new invention, they may at least be made much easier of draught, and far more secure from the danger of upsetting. Nor ought it to be unworthy of consideration, that the labor may be made far less cruelly severe upon the thousands of poor animals that are every year worn out in drawing them.